

SECTION 5 WATER SUPPLY ALTERNATIVES ANALYSIS

The section presents and screens alternatives that could meet North Reading's water supply needs. The Water Supply Needs section estimated that the town needs at least an additional 0.4 million gallons per day (MGD) of water supply to meet the Town's maximum day demand (MDD) of 2.58 MGD. This need represents the future growth of the system to accommodate existing persons currently not served by the municipal water system as well as parcels and lots that are undeveloped. The MDD also presumes the Town will reduce water consumption to 65 gpcd and the Unaccounted for Water to 10%, from current levels. The goal of this section is to identify alternatives that would most successfully meet this need, with minimum environmental impact and optimum economic impacts.

As a result of this planning effort, the Town of North Reading hopes to achieve a number of goals for their water system in addition to providing the needed surplus to meet future demands. A new water source alternative should:

- Provide a long-term and sustainable solution.
- Reduce water system complexity.
- Maintain reliable service to existing and future commercial/industrial customers.
- Keep capital, operations, and maintenance costs manageable.
- Mitigate stress on the Ipswich River Basin.

5.1 INITIAL SCREENING

As stated in the Environmental Notification Form Certificate, the town should consider three specific alternatives and combinations of these alternatives to meet projected MDDs:

- No build alternative
- In town alternative
- MWRA alternative

These alternatives are described in more detail in the following sections.

5.1.1 No Build

The "No Build" alternative evaluates impacts associated with maintaining current groundwater withdrawals from Town wells and water purchased from the Town of Andover. This alternative addresses the ability of the Town to support future growth and demand without changes to permitted withdrawal limits. The reliability of the Andover source and Town's groundwater wells is also addressed.

As stated in the Water Supply Systems section, the Town of North Reading owns and operates four groundwater supplies with a combined registered capacity of 0.96 MGD. In 2012, the Town's actual annual use from these sources in the Ipswich River basin was 0.58 MGD.

In addition to their local sources, North Reading also obtains 1.50 MGD from Andover for a total supply capacity of 2.46 MGD. The projected maximum day demand is 2.58 MGD which exceeds the capacity of the existing sources. Though the Town's permitted capacity is 0.96 MGD, the existing wells and treatment systems can only produce approximately 0.6 to 0.8 MGD. On days of maximum demand, the supply deficit is made up from purchases from Andover. The excess supply purchases may exceed the Town's existing Interbasin Transfer Act permit limitations.

In June 2014, North Reading requested assistance from Andover and sought information in order to fully evaluate different water source alternatives. The Town sought firm capacity and commitment to provide capacity over the 20-year planning period. Andover responded in July 2014 with the following:

“The available capacity of Andover’s WTP to serve North Reading is 1.5 MGD. Andover’s raw water withdrawal from the Merrimack River and Haggetts Pond is limited per the current Water Management Act (WMA) permit. This permit has a renewal date of November 2018. A full evaluation of how SWMI will impact future water withdrawals has not been completed. Due to the WMA permit, Andover is unable to commit to supplying North Reading’s project water demands of 1.5 MGD with a peak demand of 2.5 MGD for an irrevocable 20-year minimum period.”

In addition to the lack of water available, the operational reliability of Andover's interconnection is also an issue. North Reading is impacted by emergencies within Andover outside their control, such as supply interruptions from pipe breaks, hydraulic constrictions, and other system outages. In the past, North Reading has experienced interconnection limitations and a shut off, which has placed extreme burden on North Reading's ability to supply water to its customers. Finally, North Reading does not have control over user rates. North Reading pays for water as a customer of the Andover water system and rates are subject to the costs the Andover places on its tax payers. This provides a level of uncertainty and instability and may lead to higher user rates for North Reading's customers.

The no-build alternative is not a viable option for the Town. North Reading cannot meet all their needs through their own groundwater sources and the purchased water from Andover. Furthermore, this alternative creates stress on the Ipswich River Basin, as this water source has been described as “over allocated”.

As also shown in the Water Supply Systems section, the raw water quality in North Reading has declined. Iron and manganese levels have increased in source water wells. Therefore, current sources are unreliable and becoming more difficult to treat. It is anticipated that water quality from these wellfields will continue to get worse and contribute to their loss of water production. The no-build option would not help the Town as they work towards reducing system complexity and keep operations manageable.

5.1.2 Water Conservation

Though not specified as an alternative by the Town's ENF certificate, water conservation is an important part of ensuring that the Town has adequate water supply in the future. Although not explicitly stated, the Town seeks to simplify its water system through the development of a single source of water. One method to allow this to occur is a more concentrated effort on reducing water use. Under this scenario, the water use would be reduced to greater than that anticipated by the MDD 2.58 MGD. Currently in-town approvals are adequate for 0.96 MGD the current allowable registered withdrawals. In order to meet this standard the average daily usage would need to be approximately 25 gpcd. Current water use practices make this not achievable. However, as part of the baseline scenario and all other alternatives water conservation strategies should be included. This section describes the Town's current water conservation strategies, their drought management plan, IBTA water reduction measures, and municipal water conservation.

Various conservation strategies have been used successfully by water suppliers throughout the country to decrease water use during periods of high demand. Water conservation is an important alternative that should be considered in addition to the other possible local sources. In the near-term, conservation measures are needed simply to ensure that basic water service can be provided under all demand conditions. In the long-term conservation measures are needed to maintain withdrawals from local sources within registered permitted volumes.

Furthermore water conservation measures are required for the town's participation in different programs including North Reading's 1991 Water Resources Commission IBTA agreement to purchase water from Andover, MWRA water supply (OP-10 for admission & OP-5 for emergency supply), and by MA DEP for WMA permits and conditioning of well registration. By adhering to the conservation measures required by the IBTA and Drought Management Plan, the Town has the opportunity to temper non-essential water uses during periods of critical need. A summary of the Town's Water Conservation measures status, as of January 1, 2016, is shown in Table 5-1.

**TABLE 5-1
PLANNED CONSERVATION MEASURES**

Item	Action Items	Action Item Status
Drought Management	Develop and Implement Water Use Rules and Restrictions	Plan approved and completed in November 2013
Leak Detection	Identify leaking services and hydrants	<ul style="list-style-type: none"> a. Consultant completed survey of 80 miles of distribution system in December 2014 b. Leaks identified in 25 services, 11 hydrants and 2 main lines c. Estimated leakage from the leaks is 49 to 108 gpm. c. Bid opening May 13, 2015 for contractor to repair identified leaks d. As of November 2015 about half of the repairs were completed (the larger leaks) e. Remaining leaks are scheduled to do over the next six months
Meters	Evaluate towns master meters and aging residential meters	<ul style="list-style-type: none"> a. Consultant selected and began master meter evaluation Spring 2015 b. FY 16 CIP request approved for Advanced Metering Infrastructure
Water Pricing		<ul style="list-style-type: none"> a. Three-tiered increasing block water rate structure employed b. Rates and usage reviewed annually
Public Sector	Audit of Public Building Water Use	<ul style="list-style-type: none"> a. Completed in December 2014, summary is below b. FY 17 funding requesting through CIP program (for Town buildings only)
Water Audit	Identify/reduce unaccounted for water	Request FY 17 CIP funding for a water audit
Residential	<ul style="list-style-type: none"> a. Residential water use audits b. Incentives for installation of moisture based and rain shutoffs for irrigation systems 	Low priority for Town, no action taken

Industrial, Commercial, Institutional & Agricultural	a. Conduct water audits b. Develop a Water Savings Strategy	Low priority for Town, no action taken
Lawn & Landscape		a. Developed and adopted Water Use Restrictions Bylaw (191-6) and associated Rules & Regulations b. DPW enforcement authority approved Fall 2014 Town meeting
Public Education & Outreach	a. Develop and Implement Water Conservation/Restriction Program Public Education plan - Use print, social media, and Town websites - Elementary School programs - Public speaking	Not yet completed

5.1.2.1 Municipal Water Conservation

In the spring and summer of 2014, the Town hired a consultant to conduct an assessment of municipally owned and operated buildings for water conservation alternatives. The buildings included the town hall, police and fire headquarters, Flint Memorial Library, three elementary schools, DPW operations buildings, parks and recreation building, Damon Tavern, Ipswich River Park Restroom Facility, and the Building on the Common. The consultant also conducted a review of the new construction documents for the North Reading Middle-High School building.

The water-use assessment includes the review and viability associated with the replacement of fixtures as well as the expected water conservation results derived by a replacement program.

Water use associated with domestic plumbing fixtures was found to have cost effective water conservation opportunities. Depending on the particular areas or buildings and also the age and configuration of individual sanitary fixtures, the recommendations include but may not be limited to:

- Total removal and replacement of toilet and accompanying flushometer valves
- Urinal valve and or flushing mechanism rebuild or replacement

The Town's Water Department requested FY 17 funding for these upgrades. Below, in Table 5-2 is a summary of potential cost savings with these repairs. Note that this does not include schools.

**TABLE 5-2
PUBLIC WATER USE AND IMPACT OF
WATER CONSERVATION MEASURES 9/30/15**

	Water Savings	Capital Cost	Annual Water Use	Water Cost/ Tier (\$/ Tier)			Avoided O&M Cost		Rate of Return (Years)
				First Tier \$7.48/ 1000 gal	Second Tier \$10.97/ 1000 gal	Third Tier \$14.96/ 1000 gal	Annual	20 year	
Facility	(GPD)		(Gallons)	0- 10,000 gallons	10,000- 22,500 gallons	>22,500 gallons			
Town Hall	394.5	\$8,308	89,000	\$74.80	\$134.38	\$0.00	\$837	\$16,735	9.9
Police Department	160	\$614	50,000	\$74.80	\$27.43	\$0.00	\$409	\$8,178	1.5
Fire Department	67.8	\$2,404	160,000	\$74.80	\$137.13	\$261.80	\$1,895	\$37,898	1.3
Flint Library	78.7	\$8,953	73,000	\$74.80	\$90.50	\$0.00	\$661	\$13,224	13.5
Damon Tavern	0	\$0	8,000	\$14.96	\$0.00	\$0.00	\$60	\$1,197	0.0
BoC	33	\$1,823	80,000	\$74.80	\$109.70	\$0.00	\$738	\$14,760	2.5
DPW Garage	10	\$1,747	112,000	\$74.80	\$137.13	\$82.28	\$1,177	\$23,536	1.5
subtotal	744	\$23,848							
adjust for 2016 const - 2 yrs @ 3%		\$1,431							
Total		\$25,279							

5.1.2.2 Nearby Communities Water Conservation

The Massachusetts standard for residential water use is 65 gallons per capita day. As described in the Water Supply Needs section, the average residential water use in North Reading is about 67 gpcd. Thus water conservation measures are important to bring down water use. In 2014, similar communities to North Reading such as Topsfield and Reading used 51 and 46 gpcd respectively, as reported by the DEP.

Topsfield *Water Restrictions*

Topsfield's summer time use is regulated by mandatory restrictions imposed by the MassDEP. Water restrictions involve limiting non-essential water use between 9 PM and 5 PM. A 26 percent drop in May-September withdrawals and a 31 percent reduction in July-September withdrawals were observed as a result of mandatory water restrictions. This is comparing use before the restriction (1996-2005) and use after the restriction (2006-2012).

During those time periods winter time use (October-April) also dropped by 10 percent. This can be attributed to resident's gradually replacing inefficient plumbing fixtures and appliances with higher efficiency items.

On the water management side, Topsfield fully utilizes SCADA records, meter readings and withdrawal records. Most customers are billed quarterly, but the Town typically reads every meter on a monthly basis. These readings are archived and used to calculate monthly usage for each service. The system-wide use is totaled, including estimates for meters not read, and used to calculate unaccounted for water on a monthly basis. These calculations are corrected for known leaks, flushing use, etc. to try and get them as accurate as possible.

Topsfield also compares each service's monthly use it to previous years to see if there are any metered leaks that would otherwise go undetected until the next bill. A notice is mailed to the service owner if their use is unusually high. The monthly use data is also tied to a parcel based map so they can see where the water is being used. This aids in enforcement of water restrictions.

SCADA records are used to track system-wide use on an hourly basis. System use is calculated by totaling the withdrawals and correcting for storage tank changes. During the fall, winter and spring leakage is tracked by looking at early morning system-wide use (1 am to 4 am).

The SCADA records and unaccounted for water calculations are used to schedule annual leak detection surveys. The DEP requires one survey each calendar year; Topsfield uses the periodic unaccounted water calculations to identify the optimum leak detection time. Additionally, more frequent surveys are performed when calculations indicate higher levels of unaccounted water use.

Topsfield also updated their calibration methodology for master meters. They have added a cross calibration step whereby a local hydrant is measured under flowing operations and the in-situ meter is compared to the hydrant meter.

Due to the success of other programs for water conservation they have not need to offer a rebate based conservation system.

Many of the systems that have successfully managed to reduce Topsfield per capita water use have been recently been implemented or are being funded and will be implemented by the North Reading. These are likely to result in significant reductions to allow the Town to efficiently use the water supply is has.

North Reading ***Drought Management Plan***

The Town's approved DMP authorizes reductions and/or restrictions in water use during specified water emergency situations. These include increased demands, emergency conditions, catastrophic system failures, or drought conditions. The term drought refers to a prolonged period of abnormally low rainfall, resulting in a shortage of water.

The DMP was completed in November of 2013. Water Use Restrictions rules and regulations were updated in October 2010, April 2012 and March 2014. DPW enforcement authority was approved in a fall 2014 Town meeting.

North Reading's water restriction bylaw, Section 191-6, authorizes the implementation of enforcement measures needed to mitigate a drought condition through reduction/restriction in non-essential water uses. Drought restriction strategies are aimed at reducing water usage specifically in the summer higher demand period, May 1 to September 30, by controlling nonessential water uses.

For example, in May 2015, the town implemented a Stage I Mandatory Water Drought Condition, in which water use was restricted to two times per week between 7 PM and 7 AM. Violations of the restriction may result in penalties, with fines being up to \$100 daily for each additional offense after the third offense.

Planning and management is also an essential part of controlling nonessential water use before drought conditions take hold by monitoring key drought thresholds. These strategies provide the Town an opportunity to prolong the use of their sources when they become most critical. The Town may also declare a water restriction in any season if it is deemed necessary to conserve the water supply during an emergency or critical failure of the water system infrastructure.

5.1.2.3 IBTA Water Reduction Measures

The existing IBTA requires the Town to implement on-going water reduction measures to ensure the sustainability of the water supplies on a regional basis. These include the following:

- Maintaining unaccounted for water (UAW) to no more than 12 percent
- Completing leak detection surveys every 4-5 years
- Conducting Annual Statistical Report and 5 year comprehensive water auditing
- Establishing a routine meter replacement program
- Implementation of a residential household fixture retrofit program
- Public building water fixture retrofit
- Annual calibration of master meters

The Town has been completed these tasks in general conformance with the original IBTA.

5.1.3 In Town Alternatives

The ENF states that North Reading should evaluate “In Town” alternatives that assess the ability of the Town to meet current and future water supply demands through groundwater or surface water withdrawals solely from sources within the Town. Under this scenario, an interconnection with Andover would be abandoned.

A Hydrogeologic Zone Delineation for Municipal Water Supply Wells was completed in 1996 by CDM for the Town. The report states that “in 1989, recognizing that existing and potential groundwater supplies were inadequate and that approvals to construct a surface water reservoir were unlikely to be obtained, the Town initiated work on expanding the Andover connection.” In the intervening time period the ability to develop new water supply sources requires considerable permitting is more regulated and increasingly difficult than during that time period. For this study we assume there are no available groundwater and surface water supplies. Therefore, new surface and groundwater sources within North Reading will not be explored. Further discussion follows. This alternative will also evaluate optimization of existing supply and treatment systems in the Town.

5.1.3.1 Groundwater and Surface Water

The Town is located within the Ipswich River Basin which has been categorized as a “stressed basin” by the Massachusetts Water Resources Commission (MWRC). Added stress to the basin from increased groundwater withdrawals would have significant environmental impacts and may impact neighboring communities’ ability to withdraw water from the basin to serve their residents. Due to the link between the Ipswich River’s flow and groundwater withdrawals within the basin, MassDEP has imposed withdrawal restrictions and conservation measures through Water Management Act (WMA) permit conditions. As a result, permitting new sources, or increasing allowable withdrawal of existing sources is not be feasible.

In addition, the Town seeks to decrease water system complexity. Creating new groundwater supplies would in turn create additional operations and maintenance work for the Town. Additional infrastructure would need to be put into place to start up the new groundwater sources. If the new sources were located in existing wellfields, the reliability of these sources cannot be guaranteed. As reported in the earlier sections, raw water quality has declined since 1993, creating water that is more difficult to treat.

In addition to water supply capacity issues and low flows in the Ipswich, potential contamination from hazardous and oil spills are an issue. As discussed in Section 2, a number of reportable oil and hazardous waste release sites, hazardous spills and accidents, and underground storage tanks are located in Zone II protection areas in the Town. Therefore, local sources are susceptible to contamination.

5.1.3.2 Surface Water

There are several potential surface water supplies in the Town. They are Martins Pond, Eisenhaures Pond, Bradford Pond, Swan Pond. These sources were extensively studied at various times throughout the 1900s by the Town to provide additional water supply sources for the users. They have not been developed for a number of reasons, primarily:

- Lack of volume
- Impairments (Martins Pond)
- Intrinsically connected to the Ipswich River and changes in those sources would negatively impact the Ipswich River
- Serve as back up water sources for other communities (Swan Pond)

As recently as twenty years ago, the Town restudied these findings and confirmed that local surface water supplies are not available within the community.

5.1.3.3 Optimizing Local Sources

Improving North Reading's local sources is one solution to meet the Town's future water demands. The Lakeside Water Treatment Plant (WTP) is designed to treat 0.9 MGD, but only produces around 0.3 MGD or 30 percent of its design capacity. The West Village WTP is designed to treat 0.5 MGD, but only produces around 0.3 MGD or 60 percent of its design capacity. A water treatment plant optimization study determined that the wells contribute to declining treatment capacity. Upgrading or replacing these facilities is one option to help meet North Reading future needs without utilizing outside sources. As described in Section 4, Wright-Pierce conducted an optimization study for the Town's two water treatment facilities; the West Village WTP and Lakeside Boulevard WTP.

The optimization study confirmed that well production has clearly declined. This decline in well production is most likely due to declining raw water quality as discussed previously. Operational and capital improvements were suggested to optimize the treatment process:

- Adjust backwash rate at the West Village WTP.
- Increase length of filter runs at both treatment plants.
- Increase well cleaning frequency.
- Check media depth at the West Village WTP and add media as required.
- Increase frequency of lagoon cleaning at the Lakeside WTP.
- Upgrade the SCADA System at the West Village WTP.
- Evaluate changing the existing venturi flow meters to magnetic flow meters.

- Evaluate replacing the existing vacuum system at the Railroad Bed wellfield with submersible pumps and other improvements.

The proposed operational improvements will require an increase in the annual operations budget of approximately \$25,000 for additional water quality testing, and increased well and lagoon cleaning costs. The improvements will not restore them to full capacity. These facilities are also reaching the end of their typical useful life and will require significant upgrade and renewal.

While a viable, short-term option to that may help to temporarily increase water supply reliability, this is not a long term solution to the Town's needs. The Town seeks to reduce complexity in their water system, and this alternative creates more reliance on a stressed system. The Town also seeks to minimize operations and maintenance costs. This alternative would make the Town more dependent on a stressed system and would increase its operations and maintenance costs to keep it running. While improving the treatment plants may help increase capacity in the short term, this solution is not long term as raw water quality continues to decline and wells become inoperable.

Even if the Town were able to improve treatment processes enough to reach full treatment plant capacity, the Town is limited to a 0.96 MGD permitted withdrawal from the Ipswich River basin. As discussed previously, this withdrawal rate is not enough to meet to the needs of the Town's projected maximum day demands.

5.1.4 Out of Town Alternative

The ENF certificate requires a discussion of an MWRA alternative. The alternative should evaluate a connection to the MWRA water supply system that assesses the ability of the MWRA to meet current and future water demand for the Town in a manner consistent with the IBTA. To determine that an MWRA connection was the best alternative for North Reading's need for water supply, interconnections with all neighboring communities were evaluated. The evaluation determined that no community neighboring North Reading could solely supply North Reading's existing and future water demands.

This section includes a discussion of a water interconnection with neighboring communities as well as the MWRA.

5.1.4.1 Neighboring Community Interconnection

Wright-Pierce evaluated eleven communities as alternative water sources for North Reading. The communities were chosen based on a 2.5 mile radius from the North Reading town boundary, as this was assumed to be a feasible distance for interconnections.

Reading, Woburn, Wilmington, Wakefield, Peabody and the Lynnfield Water District are all MWRA customers and interconnections through those towns were considered. The remaining towns were considered solely for their local water sources.

Permitted withdrawal rates and actual 2012 water usages are based on information provided by the WMA Permitting Tool available through the MassDEP Sustainable Water Management Initiative Technical Resources page. Permitted withdrawal rates reflect those authorized for 2010.

Andover

Andover's drinking water comes from Haggetts Pond, and is supplemented with water from Fish Brook and the Merrimack River. The water is treated at the Andover Water Treatment Plant. Andover is permitted to withdraw 8.51 MGD from the Merrimack River Basin, through Haggetts Pond. Their actual annual use in 2012 was 7 MGD, 0.86 MGD of which was purchased by North Reading. Therefore, approximately 6.14 MGD was used by Andover, leaving a surplus of 2.37 MGD. In accordance with the IBTA and municipal agreement, North Readings can purchase up to 1.5 MGD of this surplus.

As stated previously, North Reading is permitted to purchase a maximum of 1.5 MGD from Andover through the Inter-basin Transfer Act (IBTA). This shows that Andover has capacity to increase North Reading's permit and North Reading could increase its withdrawals from Andover. Andover has capacity to provide North Reading's ADD but is unable to meet projected MDD of 2.58, without modifying their WMA Permit.

In June of 2014 the Town of North Reading requested information from the Town of Andover regarding alternative water sources and wastewater disposal options. Andover's response confirmed that they would be unable to supply North Reading's peak demand of 2.5 MGD. Furthermore, any costs due to improving the system to accommodate increased demands would be borne by North Reading.

Therefore, Andover's local water sources are not a long-term solution to North Reading.

Danvers

The Town of Danvers operates the Vernon C. Russell Water Treatment Plant and provides drinking water to Danvers and Middleton. The water system has 9,574 service connections, approximately 1,500 of which are in Middleton. Danvers also has secondary reservoirs at Emerson Brook in Middleton and Swan Pond in North Reading. In addition to these surface water supplies, Danvers has two water supply wells. Danvers is permitted to withdraw 3.72 MGD from the Ipswich River Basin. Their actual annual use in 2012 was 3.14 MGD.

Assuming no additional growth in Town, Danvers only has 0.58 MGD in excess capacity; therefore, Danvers is not a viable Alternative for a long-term water supply.

Reading

The Town of Reading receives its water from the MWRA, through a connection located at West Street through MWRA's Section 89. Reading's water system maintains emergency connections with neighboring water supply systems in Wakefield and Auburn. Reading's water distribution

system consists of approximately 110 miles of water main. Reading's current agreement with the MWRA allows average flows of approximately 3.8 MGD. In 2013, MWRA supplied Reading with an average flow of 1.63 MGD.

A connection to MWRA system through Reading is an alternative that requires further consideration.

Wilmington

The Town of Wilmington's water system consists of four groundwater wells, two WTPs, and approximately 126 miles of water main. Wilmington is permitted to withdraw 3.71 MGD from the Ipswich River Basin. Their actual annual use in 2012 was 2.08 MGD, leaving a surplus of approximately 1.63 MGD. The town also maintains interconnections with bordering towns and the MWRA for supplemental supply. In 2013, MWRA supplied Wilmington with an average flow of 0.31 MGD.

Wilmington's local source would not provide North Reading with a viable long-term water supply, as they have only a 1.63 MGD surplus. A connection to the MWRA system through Wilmington is an alternative that requires further consideration.

Middleton

Middleton purchases water from the Town of Danvers and is sourced from Middleton Pond. As of 2010, the Middleton Water System has 1385 residential service connections and 141 commercial and institutional service connections delivering an average flow of 0.52 MGD.

See the discussion on Danvers permitted capacity versus existing water use for more information. As discussed above, Danvers, and therefore Middleton is not a viable option because they have only 0.58 MGD surplus.

Lynnfield

The Lynnfield Water District (LWD) is one of two water districts in the Town of Lynnfield. Approximately 30 percent of Lynnfield's population (3,500 residents) is serviced by the LWD which purchases all of its water from the MWRA. In 2013, MWRA supplied the district with an average flow of 0.41 MGD.

The second water district in town is the Lynnfield Center Water District (LCWD), which obtains its water from wells owned and maintained by the District. Water is drawn from the Ipswich River Basin and North Coastal Basin. The pumping stations chlorinate, adjust pH level, and fluorinate.

LCWD is allowed to withdraw 0.32 MGD from the North Coastal Basin and 0.29 MGD from the Ipswich River Basin. The withdrawal volumes reflect an annual average daily volume, for a total system limit of 0.61 MGD. Their total actual annual use in 2012 was 0.57 MGD.

LCWD is not a viable alternative for a long-term water supply, as their current water usage leaves only a surplus of 0.04 MGD.

North Andover

North Andover's main drinking water source is Lake Cochichewick which holds approximately 43 billion gallons of water. North Andover's WTP removes roughly 1.1 billion gallons every year from the lake. In the period between 2009 and 2014 they were authorized to withdraw 4.40 MGD from Lake Cochichewick. Their actual annual use in 2012 was 3.35 MGD.

The limitation of the Firm Yield of Lake Cochichewick is 4.66 MGD, leaving a maximum surplus of 1.31 MGD based on 2012 water usages. MassDEP has identified that North Andover will need to develop an additional drinking water source. Since North Andover does not have capacity to meet their own future demands, they will not be able to provide 2.58 MGD to North Reading.

Peabody

Peabody's drinking water is mainly supplied by the Coolidge and Winona WTPs. At Winona WTP, water is pumped from Winona Pond for treatment. At Coolidge WTP, water is pumped from Suntaug Lake and Spring Pond for treatment. The source of water for Suntaug Lake and Winona Pond is the Ipswich River. Peabody is permitted to withdraw 3.89 MGD from the Ipswich River Basin and 1.89 MGD from the North Coastal River Basin. Their actual annual use in 2012 was 4.62 MGD from the Ipswich River Basin and 1.32 from the North Coastal River Basin.

Peabody's local sources would not be a viable option for North Reading.

MWRA provides supplemental drinking water to Peabody during high water demand months. In 2013, MWRA supplied Peabody with an average flow of 1.031 MGD. A connection to MWRA system through Peabody is not a viable option since a connection would have to be made through Middleton or Lynnfield. A direct connection to MWRA at the Town border with Reading and Wilmington is more direct and efficient.

Tewksbury

The Town of Tewksbury's WTP has a capacity to treat 7.0 MGD. Water is sourced from the Merrimack River and serves over 10,000 residential and commercial facilities. The town is permitted an annual average withdrawal from the Merrimack of 3.17 MGD. Their actual annual use in 2012 was 2.39 MGD.

Tewksbury is not a viable option for North Reading without increase of withdrawal from the DEP through their WMA, as there is only a 0.78 MGD surplus available.

Wakefield

The Wakefield Water Department (WWD) purchases approximately 85 percent of its water supply from the MWRA, through a connection in Melrose. In 2013, MWRA supplied Wakefield with an average flow of 1.362 MGD. During peak demand, about 15 percent of Wakefield's water is drawn from Crystal Lake Reservoir and treated at the Broadway Treatment and Pumping facilities.

The WWD is registered to withdraw 0.48 MGD from Crystal Lake through the North Coastal Basin. Their actual use in 2012 was 0.34 MGD. Therefore, a 0.16 MGD surplus would not be enough to supply to North Reading.

A connection to MWRA system through Wakefield is not a viable option since a connection would have to be made through Reading or Lynnfield. A direct connection to MWRA at the Town border with Reading and Wilmington is more direct and efficient.

Woburn

The City of Woburn's water supply comes from five wells within the Horn Pond area, which is then treated at the Horn Pond Treatment Plant. The city is permitted to withdraw 4.07 MGD from the Boston Harbor Basin, approximately two-thirds of the city's water supply. Their actual annual use in 2012 was 2.01 MGD, leaving a 2.06 MGD surplus that would not fulfill North Reading's needs. The MWRA supplements the remaining one third of the town's water supply with an average flow of 2.563 MGD in 2013.

A connection to MWRA system through Woburn is not a viable option since a connection would have to be made through Reading or Wilmington. A direct connection to MWRA at the Town border with Reading and Wilmington is more direct and efficient.

5.1.4.2 MWRA Connection

As stated previously, a connection to the MWRA system through Reading and Wilmington are viable alternatives as they both border North Reading. A connection through Wilmington is feasible. Some considerations for a connection through Wilmington are as follows:

- Blended water from the local sources in Wilmington and MWRA adds complexity to operations for Wilmington.
- Local supplies in Wilmington are drawn from the Ipswich River basin. Wilmington maintaining these supplies would complicate permitting and create technically challenging infrastructure requirements. Systems would require to be developed to ensure that the water used by North Reading was sourced from the Chicopee/Nashua River and Wilmington local sources could not be used to provide water to North Reading.

Wilmington was contacted by North Reading to assess the feasibility of "wheeling" water from the MWRA through their distribution system. Wilmington indicated they were willing to discuss that as an option.

A connection to the MWRA system through Reading is more feasible since it is 100% MWRA water reducing complexities previously discussed. Analysis on this option has been conducted and is presented later in this section. During initial evaluation the complexities of the connection through Wilmington as well as the potential need for greater infrastructure improvements to support a connection through Wilmington, the Reading connection was selected for detailed analysis.

Further analysis of an MWRA connection through Wilmington was not considered. Two conceptual alternatives for connection to the MWRA system through Reading have been considered; a direct connection to MWRA and an indirect connection by “wheeling water” through Reading.

Investment in infrastructure will be required to make a connection to the MWRA system. Improvements are anticipated in the North Reading water system as well as the Town of Reading. The exact limits and nature of the improvements will not be known until negotiations between communities and the MWRA have been completed. At a minimum, a pumping station will be required to booster water from MWRA to North Reading. Improvements to Reading’s water distribution system will also be required, the extent of which will be finalized as part of an Inter-Municipal Agreement.

Direct Connection to MWRA

The Town investigated the feasibility of constructing a dedicated transmission main from the closest point to the MWRA system to North Reading. Conceptually, the closest location to the MWRA system is near the intersection of I-93 and I-95 in Reading. From this location, approximately six miles of pipe would be required to make a connection to one of several points of the North Reading distribution system. Assuming required pipe diameter of 24-inch at a cost to construct of \$300 - \$400 per linear foot, the cost of the transmission main could be approximately \$9.5 – \$12.7M. And, similar to the alternative of connecting to Reading, a booster pumping station would be required to transfer flows from the MWRA system into North Reading. It was determined that because of significant construction impacts and cost, this option would not be considered.

Wheel Water through Reading

Another option would be to “wheel” water from the MWRA through Reading’s water distribution system into North Reading. This alternative requires a hydraulic analysis of the Reading’s water distribution system to convey increased flows to North Reading on a sustained basis. Upgrades to Reading’s distribution piping network will be required to support the increased flows. And, because the hydraulic operating gradeline of Reading’s water system is lower than North Reading’s hydraulic gradeline, a booster pumping station would be required to transfer flows from Reading into North Reading at the interconnection. In conjunction with this study, Wright-Pierce conducted a conceptual hydraulic analysis to evaluate the capacity of the Town of Reading’s distribution system to accommodate higher flows. The results are summarized later in this section. The analysis outlines several recommended improvements to Reading’s system that may be required. North Reading would likely be responsible for funding many of these required projects. Reading is currently permitted to withdraw up to 766.5 MGY from MWRA. If the Town were to “wheel” water through the Town of Reading’s water

distribution system, their water supply partially reliant on the reliability of Reading's water system.

5.2 ADVANCED ALTERNATIVES ANALYSIS

This section will look at the final alternative in more depth. The screening analysis eliminated all other alternatives from consideration as a connection to the MWRA system meets the primary goals and objectives of the Town. The final recommended alternative includes a connection to the MWRA water supply by "wheeling water" through Reading and the water conservation alternative.

5.2.1 MWRA Connection

A connection to the MWRA water supply by "wheeling water" through Reading is an alternative that has been chosen for further analysis. The Town wants to obtain a new water supply such as the MWRA by July 2019. Therefore, it is imperative that the Town make investment in the existing facilities to assure continuous service. Establishing an interconnection with MWRA would include the completing the IBTA process through the EIR process as well as an application, OP 10, and a one-time entry fee to MWRA. If the Town pursues this option, the Town will discontinue withdrawal from its own water sources and will forfeit its WMA registration. In addition, the agreement to purchase water from Andover would be reduced to emergency withdrawals only and serve as a redundant/back-up connection.

As stated in the Town's ENF Certificate, "comment letters received are generally supportive of the Town's proposal to connect to the MWRA's water supply and forfeit its WMA registration of 0.96 MGD." Furthermore, the MWRA has confirmed capacity to serve the Town's request to purchase approximately 1.6 MGD of water on an annualized basis water supply for the Town. The MWRA has also stated they can meet North Reading's MDD of 2.58 MGD.

This section will look at the components required to implement this alternative as well as the pros and cons of this alternative. In this alternative it is assumed the Andover interconnection will be maintained for emergency purposes. This section will also look at the action items involved in making this alternative happen. These include:

- Design and construction of new water mains through Reading and North Reading
- Addition of a Water Booster station
- MWRA OP #10 admission criteria and MWRA costs
- Fulfillment of regulatory requirements associated with new water permits and decommissioning of current treatment plants

5.2.1.1 Advantages and Disadvantages

There are many advantages to a connection to the MWRA, besides ensuring adequate water supply for the Town. These advantages help meet the Town's needs and include:

- Reduced water system complexity - Once abandoned and decommissioned, water department staffing and O&M costs for the wellfields and treatment facilities can be reallocated. This will result in lower operating costs and a simpler system to maintain. The MWRA is responsible for maintaining their system, so the Town would only be responsible for maintaining its water distribution system and emergency connection with Andover.
- Positive environmental impacts - Comment letters received as part of the ENF process note positive environmental benefits of reducing water withdrawals from the stressed Ipswich River basin. “As noted by MassDEP, reducing water withdrawals from the subbasin within which North Reading wells are located will benefit stream flow and habitat conditions” Authorized water withdrawals within the Ipswich River basin in November of 2012 were up to 32.8 MGD, 3.4 MGD more than the draft safe yield for the basin. “MassDEP indicated that while actual water withdrawal volumes have been significantly lower than allocated volumes, efforts to reduce active allocations below safe yield are needed.”
- Reliability - Although North Reading would still not be in control of the water source, they would now be a customer with equal rights and priority as all of MWRA’s municipal customers. MWRA provides a high quality and reliable water supply and rate increases are regulated. The costs of system upgrades and meeting new regulatory requirements are spread among a larger user base.

There are also a few disadvantages and factors to consider related to this alternative.

- Negative environmental impacts – While this solution is sustainable in that it reduces stress on the Ipswich River Basin, construction of new water main is required. Emissions from construction as Greenhouse gases (GHG) and other negative environmental impacts associated with construction are anticipated. However abandonment of the Town’s local sources would help offset the temporary construction related increase in GHG emissions by eliminating a majority of the electrical demands associated with current production.
- Capital costs – Significant capital costs would be involved in construction and improving the Reading water system to allow for the water wheeling. Though the Town’s operation and maintenance costs would decrease, the additional cost of purchasing water from the MWRA should be considered.
- Loss of control of water source and supply. Dependency on Reading for reliable water transmission services for the MWRA supply.
- MWRA water is disinfected by chloramination and Andover is disinfected by chlorine. By maintaining an emergency connection with Andover, the Town would need to be aware and closely monitor water in their distribution system. When free chlorine from chlorinated systems blend with water with chloramines, the ratio of chlorine, ammonia and monochloramines changes in an uncontrolled way and could impact disinfection of the distribution system. This is anticipated to occur only under extremely rare circumstances – in case of emergency.

5.2.1.2 Reading and North Reading System Upgrades

This section discusses the logistics and system upgrades necessary when “wheeling” water from MWRA through Reading.

The Town of Reading provided a letter of support, dated November 4, 2014, regarding the willingness of Reading to collaborate with North Reading in their efforts to become an MWRA water customer and “wheel” MWRA water through their system. Reading’s staff worked closely with North Reading by providing the technical information that was necessary to make an evaluation of any potential impacts to the Reading water distribution system and to identify any modifications/improvements that may need to be done to accommodate North Reading. A hydraulic analysis was conducted to analyze these impacts. Reading provided their hydraulic model, developed by Weston & Sampson, for this analysis. Data related to the MWRA system at the point of interconnection was provided by MWRA. Modeling was conducted by Wright-Pierce with QA/QC provided by Weston & Sampson and the MWRA.

The objective of the analysis was to establish baseline conditions of Reading’s water system without flows to North Reading, and then evaluate the impacts to Readings system with added demands to North Reading under various scenarios. The scenario that all parties were comfortable moving forward on during preliminary design was maximum day demands to both systems plus fire flow assuming two MWRA connections. Improvements required to Reading’s water distribution system included the following and are shown in Figure 5-1.

- Auburn Street Tank – Replace Inlet/Outlet piping
- Auburn Street Tank – Replace From Auburn Street to Main Street
- Reactivate 24-inch cross-country water main from Forest Street to Franklin Street
- Woburn Street- Replace from Summer Avenue to Linden Street
- Linden Street - Replace from Woburn Street to Lowell Street (Completed by Reading in their CIP)
- Franklin Street - Replace 8-inch from 24-inch cross-country main to Main Street

A hydraulic model analyzed the option of wheeling water from the MWRA water system through the Town of Reading water system to North Reading. The model was developed by Weston & Sampson. The modeling simulations were made assuming that proposed improvements to the MWRA system will be made by 2019.

The first model looked at impacts to Reading’s system with two MWRA connections to North Reading under the 2030 ADD and MDD. Elevated pipe velocities were noted in some pipes during MDD conditions. Therefore, increased pipe diameter in these areas was suggested as an improvement. Low pressures (under 20 psi) were also observed under certain fire flow conditions. Cleaning and replacing certain lines was recommended as a solution to this issue.

The second model looked at impacts to Reading’s system with a single MWRA connection to North Reading under 2030 ADD and MDD. Reading’s Auburn Street tank water level dropped more than 10 feet during MDD conditions. To alleviate this problem, it was recommended that certain lines be replaced and cleaned. Like the first scenario, fire flow conditions resulted in

system pressure to fall below 20 psi. Fire flow conditions were run assuming suggested improvements were made.

It was determined that the normal system condition would be two MWRA connections.

Further modeling, analysis, and design, may be required upon final acceptance of this plan.

5.2.1.3 MWRA Withdrawal and Costs

Assuming an average annual withdrawal of 1.6 MGD from the MWRA, the entrance fee, based on expected use, will be approximately \$7M. Current policy allows this to be paid over 25 years at zero interest with the first payment due 3 years after connection. Additionally recent legislation may provide some grant support to this connection fee.

Additional capital costs that will be incurred as part of the project include upgrades to the Reading and North Reading systems. The extents of these improvements are still under analysis and negotiation and will not be precisely known until the finalization of permitting to allow for the progress of formal design tasks.

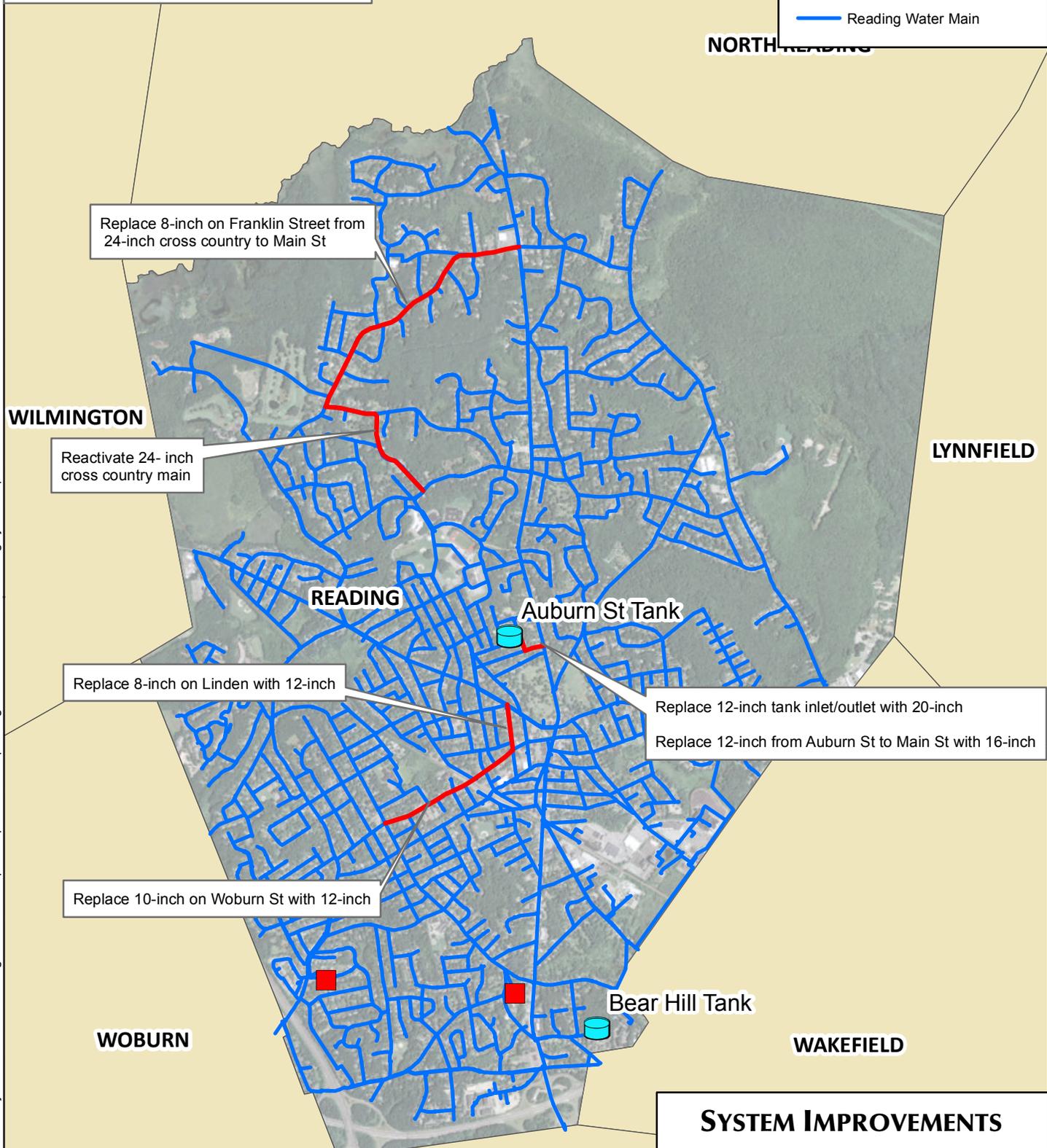
A detailed water cost model was derived to examine the rate differential between the current operating condition and the provided by a connection to the MWRA. It did identify short-term increases in the user rates to Town of North Reading users, but under long-term scenario (less than 10 years after connection), rates will stabilize and become more predictable than under the current condition.

Base data obtained from Town of North Reading, MA; Town of Reading, MA; and the Massachusetts Office of Geographic Information

Map produced by Wright-Pierce, 2015

- Reading MWRA Connection
- Reading Water Tank
- Proposed Improvement
- Reading Water Main

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1 inch = 3,000 feet
 0 1,500 3,000 6,000 Feet

Source: Esri, DigitalGlobe, GeoEye, IGN, CNES/Airbus DS, USDA, USDA, USDA, swisstopo, and the

SYSTEM IMPROVEMENTS	
Town of Reading, MA	
PROJ NO: 12820	DATE: 1/7/2016
WRIGHT-PIERCE Engineering a Better Environment	
FIGURE: 5-1	

5.2.1.4 MWRA Policy OP#10 Admission Criteria

In order for the Town of North Reading to apply for admission to the MWRA system, the extension must be approved by a majority vote of the town meeting. From there the Town must adhere to MWRA Policy OP.10: Admission of New Community to MWRA Water System. “This policy applies to communities seeking admission to the MWRA water system, and to state, county, institutional, and federal facilities seeking MWRA water for a location outside MWRA’s water service area, as defined in MWRA’s Enabling Act.”

Overall, “any expansion of the MWRA water service system shall strive for no negative impact on the interests of the current MWRA water communities, water quality, hydraulic performance of the MWRA water system, the environment, or on the interests of the watershed communities; shall attempt to achieve economic benefit for existing user communities; and shall preserve the rights of the existing member communities. Any evaluation of the impacts of new communities shall clearly evaluate all changes to system reliability.”

Certain criteria must be met in order to permit the admission of a new community to the MWRA waterworks community. “The MWRA must, in accordance with Section 8 (d) of Chapter 372 of the Acts of 1984, find that the following six criteria are met:

- The safe yield of the watershed system, on the advice of the MDC, is sufficient to meet the new community’s demand.
- No existing or potential water supply source for the community has been abandoned, unless the Department of Environmental Protection (DEP) has declared that the source is unfit for drinking and cannot be economically restored for drinking purposes.
- A water management plan has been adopted by the community and approved by the Water Resources Commission.
- Effective demand management measures have been developed by the community, including the establishment of leak detection and other appropriate system rehabilitation programs.
- A local water supply source feasible for development has not been identified by the community or DEP.
- A water use survey has been completed which identifies all users within the community that consume in excess of twenty million gallons a year.

Additional requirements include approval from MWRA Advisory Board, the General Court, and the Governor.

The information contained within this study provides the necessary background to establish and meet the criteria established in the OP.10 application.

5.2.1.5 Permits and other regulatory considerations/IBTA Requirements/Decommissioning of water treatment plants/wells

Establishing an interconnection with MWRA would include the gaining a new IBTA permit as well as an application, OP 10, and a one-time entry fee to MWRA. If the Town pursues this option, the Town will discontinue withdrawal from its own water sources and will forfeit its WMA registration. In addition, the agreement to purchase water from Andover would be reduced to emergency withdrawals only and serve as a redundant connection. Also, by maintaining an emergency connection with Andover, an emergency connection between Andover and Reading may result and allow Reading to fully abandon their local sources.

As stated in the ENF, a connection to the MWRA water supply triggers the IBTA since the Town is located in the Ipswich River basin and the MWRA's sources are located in the Chicopee and Nashua River.

An MWRA connection would require the Town to forfeit their current WMA Permit of 0.96 MGD. Abandonment of the existing wellfields and water treatment facilities will require an abandonment permit and design and construction of the abandonment.

The IMA with Andover would not be renewed when it expires on July 1, 2019.

5.2.2 Water Conservation Alternative

Water conservation efforts are a cost effective means of reducing demand. While North Reading has approved a Drought Management Plan, which will aid in water conservation, additional approaches should be considered in order for North Reading to meet their future water demand needs. Water conservation efforts are recommended as a part of all alternatives.